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EFFICACY OF MCH TO PREVENT SPRUCE BEETLE INFESTATION

By

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Abstract

MCH, contained in plastic bubble caps, was released in stands of standing spruce at the rate of 40 bubble caps per acre. Although significant differences were not detected, trees in those plots treated with MCH sustained fewer spruce beetle attacks than did trees in untreated plots.

Introduction

Spruce beetles (Dendroctonus rufipennis (Kirby)) infest all species of spruce especially Engelmann spruce (Picea engelmannii Parry) in the central Rockies. Fallen spruces, often the result of windthrow, are preferred to standing trees. The infestations which develop in these fallen trees can precipitate widespread beetle outbreaks. (Schmid and Frye 1977).

Generally, adult beetles attack trees once annually with resulting broods taking 1-3 years to develop. Adults usually fly in June and July; bore through the bark and deposit eggs along galleries they construct in the phloem. Over the next 12-36 months following egg hatch the larvae feed in the phloem eventually girdling the host tree (Schmid and Frye 1977).

Both attractive and antiaggregative pheromones for spruce beetle have been tested and are used to manipulate populations of adult beetles. Schmid and Frye (1977) discuss these materials at length.

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Frontalin and alpha-pinene attract beetles and 3-methyl-2-cyclohexen-1-one (MCH) represses spruce beetle attack (Kline et al. 1974). Recently, Lindgren et al. (1989) reduced spruce beetle attack density and total beetle brood production in felled spruce using MCH released from plastic bubble caps attached to the fallen trees.

This investigation tested MCH, released from bubble caps, on standing uninfested spruce where beetles were present. The objectives of the test were to determine: (1) the efficacy of MCH to prevent spruce beetle infestation in the presence of spruce beetle baits containing frontalin and alpha-pinene, and (2) efficacy of MCH to prevent spruce beetle infestation in spruce stands.

Methods and Materials

Five replicates of four treatments were tested using a randomized block design. Treatments within each replicate consisted of: (1) spruce beetle bait, (2) MCH, (3) spruce beetle bait and MCH, (4) experimental control. Each treatment was applied to a 2.5 acre plot and replicated five times resulting in twenty 2.5-acre plots. Plots were square, five chains on a side, and spaced 5 chains apart.

The four plots within a replicate were as uniform as possible to minimize stand effects on the treatment. Spruce was to constitute 75% or more of the stand and plots were to contain 3-10 infested trees. Perfect uniformity was not essential because treatment effects were to be based on percent of trees infested.

MCH and baits were obtained from Phero Tech Inc.. Baits contained frontalin and alpha-pinene. MCH was loaded in plastic bubble caps which daily released 0.5 mg of MCH.

MCH bubble caps were evenly spaced throughout the plots in a grid pattern. Grid spacing was approximately 1/2 ch X 1/2 ch (40 caps/ac). Each cap was stapled to the bark, 6-7 feet above ground, on the north side of the tree that was closest to the grid coordinate regardless of tree species. Spacing was maintained as closely as possible.

Five spruce beetle baits were used in the baited plots. Baits were applied 6-7 feet above ground on the north side of a spruce 10" DBH or larger. One bait was placed at the center of the plot. The remaining 4 baits were placed at 90 degree intervals from the center bait approximatley 1 ch from the plot boundary.

In winter and early spring 1991, two replicates were established on the Payette National Forest, Idaho, and three on the Wasatch-Cache National Forest, Utah. Pheromones were deployed in April in advance of beetle flight.

In the fall of 1991, following beetle flight, all trees 5 inches DBH and larger were examined on all plots. Species and diameter of each tree were tallied. All tallied spruce were categorized as uninfested, killed prior to 1990, killed in 1990, or currently infested - 1991.

Data were tabulated and summarized. Means and 95% confidence intervals were used to analyze the data.

Results and Discussion

Pretreatment

Total stocking density ranged from 234 trees/plot to 1442 trees/plot (Table 1). There were no significant differences in total stocking density.

Spruce stocking density ranged from 127 trees/plot to 882 trees/plot (Table 1). There were no significant differences between treatments with respect to spruce stocking.

Table 1. Numbers of live trees >5" DBH on test plots before treatment.

Number of Live Trees

	treatments			
replicate	bait only	MCH only	bait+MCH	control
1 (Idaho)	419	254	234	241
2 (Idaho)	346	426	372	319
3 (Utah)	618	1383	614	1442
4 (Utah)	687	598	668	481
5 (Utah)	657	428	416	394
$\bar{X}$	545.4	617.8	460.8	575.4
S.E.	68.38	198.88	79.92	220.27

Number of Live Spruce

	treatments			
replicate	bait only	MCH only	bait+MCH	control
1 (Idaho)	127	156	190	163
2 (Idaho)	178	366	180	169
3 (Utah)	388	882	276	831
4 (Utah)	379	274	276	192
5 (Utah)	300	163	287	199
$\bar{X}$	274.4	368.2	241.8	310.8
S.E.	52.68	134.16	23.34	130.23

The baited plots averaged only slightly more than 49% live spruce, the control plots almost 54% live spruce, the bait + MCH plots 57% live spruce and the MCH plots 59% live spruce before treatment (Table 2). Only two individual plots met the 75% spruce stocking density minimum stipulated in the study plan. There was no significant difference in the mean live spruce makeup with respect to treatment.

Table 2. Percent of live spruce >5" DBH before treatment.

Treatment	Replicate					$\bar{X}$	S.E	95% conf. int.	
	1	2	3	4	5			lower	upper
Spruce beetle bait	30.3	51.4	62.8	55.2	45.7	49.1	5.46	33.94	64.26
MCH	61.4	85.9	63.8	45.8	38.1	59.0	8.27	36.04	81.96
Spruce beetle bait + MCH	81.2	48.4	45.0	41.3	69.0	57.0	7.74	35.51	78.49
Control	67.6	53.0	57.6	39.9	50.5	53.7	4.52	41.15	66.25

From 0 to 28 trees per plot were killed by beetles before treatment. Most pretreatment spruce beetle activity was found on those plots treated by bait + MCH where an average 5.6 trees were infested (Table 3). Only 2 individual plots met the planned pretreatment standard of 3 to 10 infested trees per plot.

Table 3. Numbers of spruce trees >5" DBH attacked by spruce beetles on test plots.

Numbers of Spruce Attacked in 1990 Before Treatment

	treatments			
replicate	bait only	MCH only	bait+MCH	control
1 (Idaho)	0	0	0	4
2 (Idaho)	0	0	0	2
3 (Utah)	0	3	28	0
4 (Utah)	1	0	0	1
5 (Utah)	0	1	0	1
$\bar{X}$	0.2	0.8	5.6	1.6
S.E.	0.20	0.58	5.6	0.68

Numbers of Spruce Attacked in 1991 After Treatment

replicate	bait only	MCH only	bait+MCH	control
1 (Idaho)	4	0	1	58
2 (Idaho)	0	23	0	75
3 (Utah)	108	4	25	4
4 (Utah)	29	0	5	0
5 (Utah)	31	0	15	4
$\bar{X}$	34.4	5.4	9.2	28.2
S.E.	19.45	4.47	4.74	15.88

Post Treatment

Consistent with some literature (Dyer and Hall 1977, Kline et al 1974, Lindgren et al 1989) plots treated with MCH experienced less spruce beetle activity in 1991 than plots not treated with MCH. On average, the plots treated with MCH had 5.4 trees attacked and those treated with baits + MCH had 9.2 trees attacked. In contrast the control plots averaged 28.2 trees attacked while the baited plots had 34.4 trees attacked (Table 3).

To compensate for plot differences we converted data to percent attacked spruce (Table 4). The trend of percent spruce attacked was similar to the unconverted data. The average percent spruce attacked ranged from 1.3% in the MCH plots to 16.5% in the control plots; a greater than 91% difference. This finding is similar to that of Lindgren et al (1989) who reported an 85% reduction in spruce beetle attacks in the presence of MCH. The differences in percent spruce attacked however were not significant (Figure 1).

We found similar results when computing the percent change in attacked spruce from 1990 to 1991. On average all treatments experienced increased spruce beetle activity in 1991 but the percent increase was less in those plots influenced by MCH than in those plots without MCH influence (Table 5). The differences in percent change of attacked spruce were not significant (Figure 2).

Previous studies with MCH and spruce beetle were conducted using traps (Kline et al 1974), spruce stumps (Dyer and Hall 1977), and felled trees (Lindgren et al 1989). All these investigations showed that MCH effects a statistically significant reduction in spruce beetle activity. Our investigation is the first where MCH released from bubble caps was used in live spruce. Although similar to the above investigations, where MCH exhibited an influence, we cannot detect a significant reduction in activity. Perhaps the number of MCH releasers, in this case bubble caps, needs to be increased to achieve more consistent results.

Table 4. Percent live spruce >5" D8H mass attacked in 1991 by treatment.

Treatment	Replicate					$\bar{X}$	S.E	95% conf. int.	
	1	2	3	4	5			lower	upper
Spruce beetle bait	3.15	0	27.83	7.65	10.33	9.792	4.849	-3.669	23.253
MCH	0	6.28	0.45	0	0	1.346	1.237	-2.087	4.779
Spruce beetle bait + MCH	0.53	0	9.06	1.81	5.23	3.326	1.698	-1.389	8.041
Control	35.58	44.38	0.48	0	2.01	16.490	9.696	-10.426	43.406

Figure 1. Percent Spruce Attacked in 1991
mean +/- 95% confidence interval

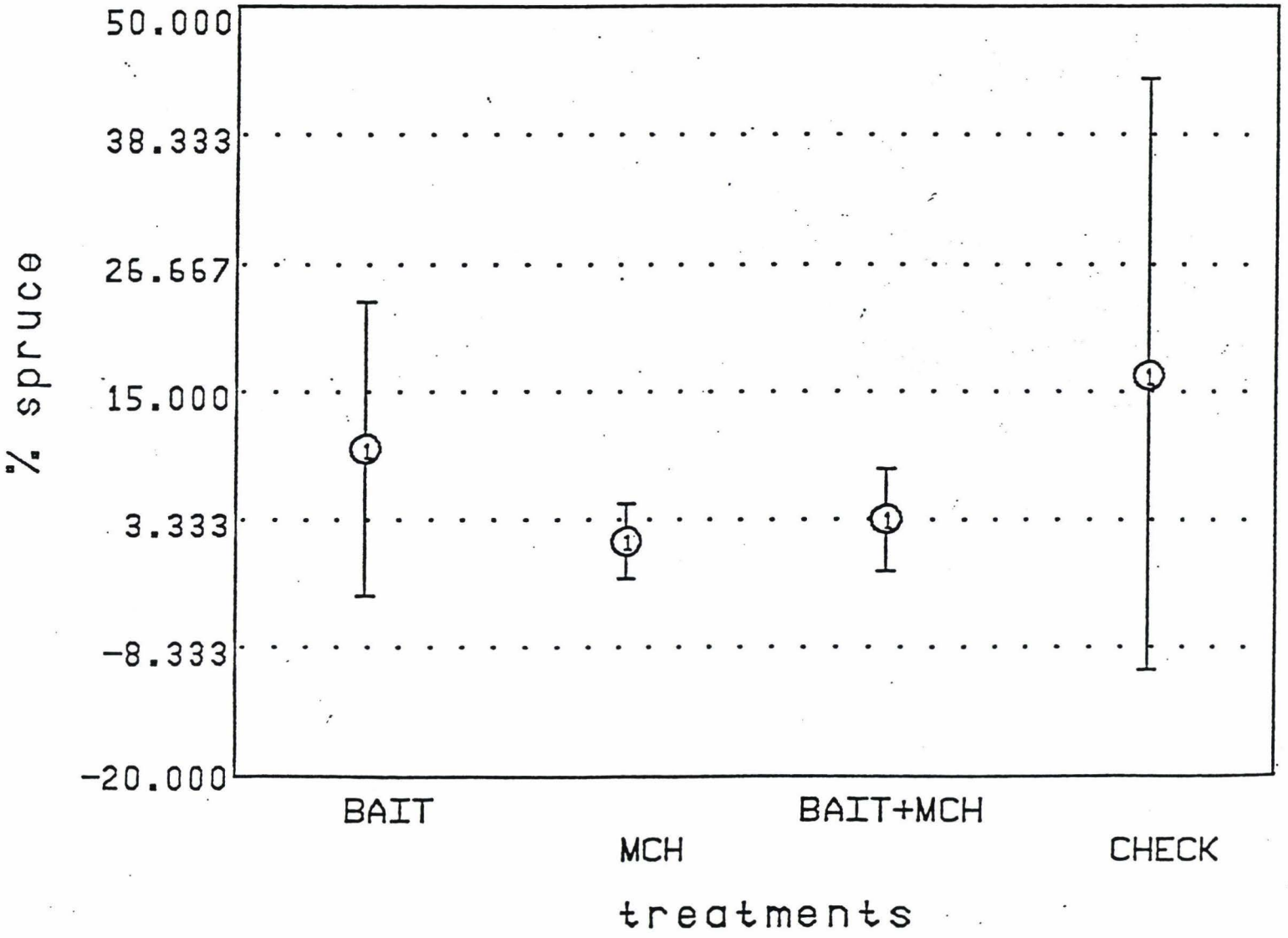
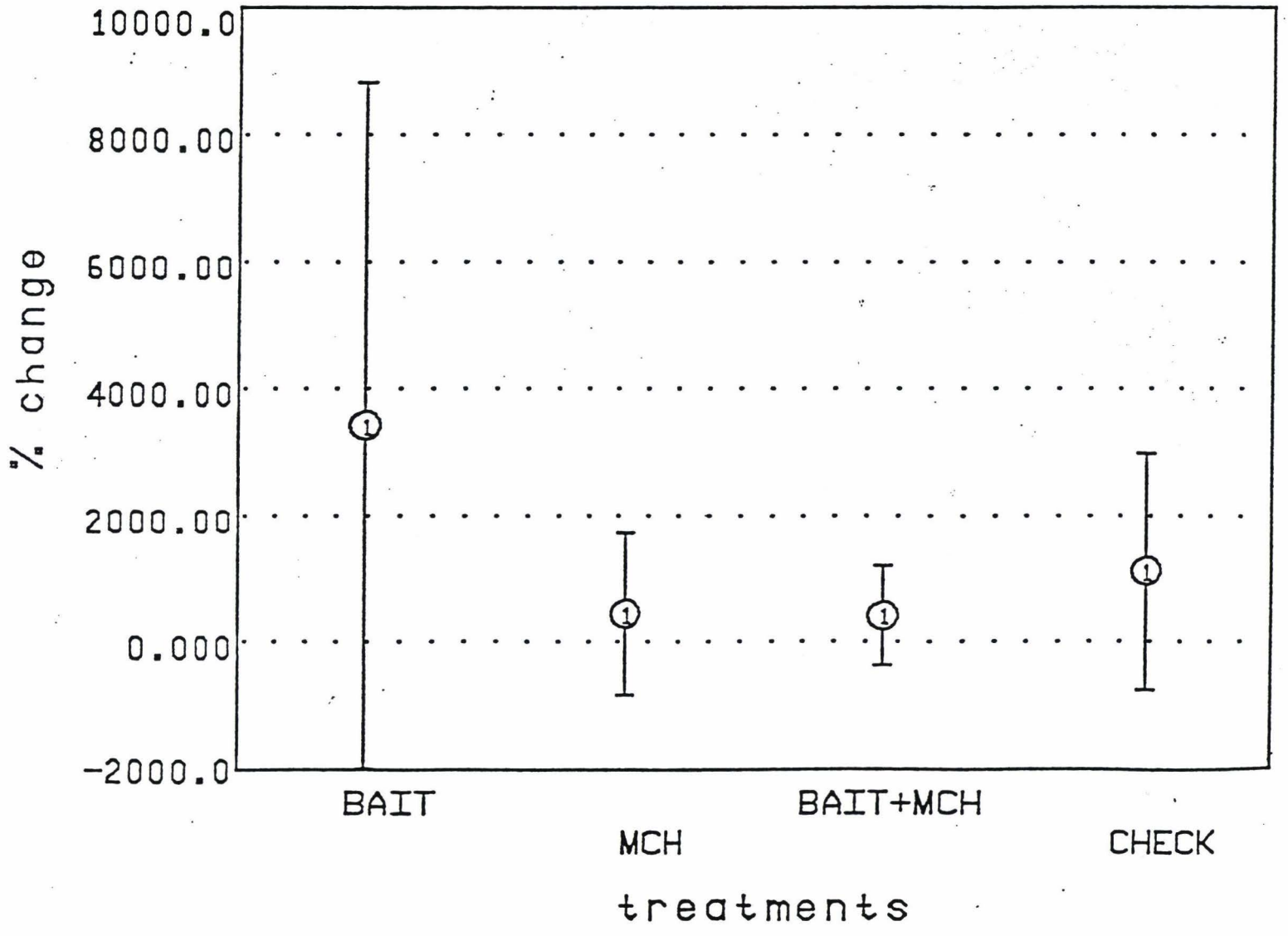


Table 5. Percent change in number of attacked spruce from 1990 to 1991 by treatment.

Treatment	Replicate					$\bar{x}$	S.E	95% conf. int.	
	1	2	3	4	5			lower	upper
Spruce beetle bait	400	0	10,800	2800	3100	3420.0	1946.38	-1983.15	8823.15
MCH	0	2300	33	0	-100	446.6	463.89	-841.16	1734.36
Spruce beetle bait + MCH	100	0	-11	500	1500	417.8	286.12	-376.47	1080.39
Control	1350	3650	400	-100	300	1120.0	675.76	-755.91	2995.91

Figure 2. Percent Change Attacked Spruce 1991
mean +/- 95% confidence interval



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